# National Water Conditions

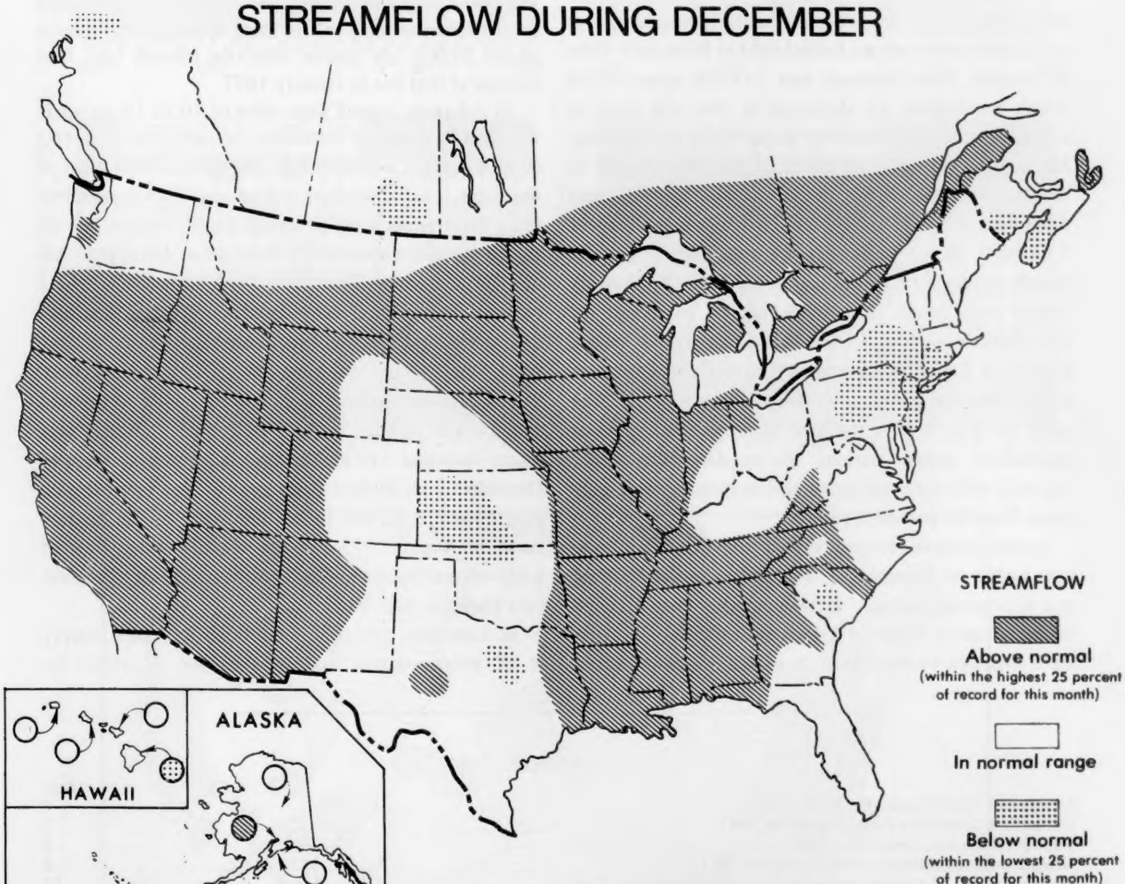
(Formerly the Water Resources Review)

UNITED STATES
Department of the Interior
Geological Survey

CANADA
Department of the Environment
Water Resources Branch

DECEMBER 1982

## STREAMFLOW DURING DECEMBER




Severe flooding during the period December 3—10 in Arkansas, Illinois and Missouri resulted from heavy rains early in the month, and runoff from intense rains in Louisiana and Mississippi caused widespread flooding in those two States at monthend. Peak discharges of many streams exceeded those likely to occur only once in 100 years. Forty counties in Arkansas and fifteen counties in Missouri were declared disaster areas as a result of flood and tornado damage.

Streamflow was in the normal range or above that range in most of the United States and southern Canada during December, and monthly mean flows were highest of record for the month in parts of at least 14 States.

## STREAMFLOW CONDITIONS DURING DECEMBER 1982

Streamflow remained in the above-normal range (within the highest 25 percent of record for the month) in parts of at least 23 states from New York west to California and increased into that range in most of the Southeast as a result of runoff from rains that averaged much above normal during December.

Floods with recurrance intervals that equalled or exceeded 100 years occurred in parts of Arkansas, Illinois, Louisiana, and Missouri during December. Upstream from the area of major flooding and indicative of the above-normal trend in streamflow throughout most of the upper Mississippi River Valley was the monthly mean discharge of 125,600 cubic feet per second (cfs) at Mississippi River at Keokuk, Iowa (drainage area, 119,000 square miles) which was highest for December in over 100 years of continuous record. Similarly, downstream at Vicksburg, Mississippi, and reflecting much of the flood runoff in the Midcontinent during December, the monthly mean discharge of 1,145,900 cfs and the daily mean flow of 1,399,000 cfs on December 19 were highest for the month in period of record that began in 1928. Monthly and/or daily mean flows were highest of record for December in parts of 15 States and remained at record high levels for at least 3 consecutive months in parts of Iowa, Nebraska, Nevada, North Dakota, and Utah. The table on page 4 lists the new extremes established at streamflow index stations during December 1982 together with the previous maximum monthly and daily mean flows for period of record.

In southeastern Missouri, runoff from rainfall of up to nine inches on December 3, 4 caused extensive flooding and widespread damage. Fifteen counties were declared disaster areas by President Reagan on December 10. Interstate Highway 44 was closed in several places in central Missouri as a result of floodwaters over the road. The accompanying table and map on pages 5, 6, 7 show peak stages and discharge data at selected gaging stations in Missouri, Arkansas, Illinois, and Louisiana for the floods of December 1982. In south-central Missouri, the monthly mean discharge of 17,795 cfs and the daily mean flow of 119,000 cfs on the 5th at Gasconade River at Jerome, Missouri, were highest for the month in 62 years of record and about twice the prevous record highs recorded at that site in December 1942. (See graph on page 3.) The corresponding peak discharge of 140,000 cfs on December 5 was generated entirely from the 2,840 square mile contributing drainage area and was about 20,000 cfs greater than the historic high flow reached at that site in January 1897.

In Arkansas, runoff from rains of 10 to 14 inches in less than 24 hours on December 3 caused severe flooding in west-central, north-central, and northeastern areas of the State. Peak discharges exceeding the 100 year recurrence interval occurred at several gaging stations and six gaging stations were severely damaged or destroyed. Additional storms on December 26–27 produced 4 to 7 inches of rain in south-central and southeastern Arkansas and severe flooding was experienced in the city of Pine Bluff where two lives were lost. Forty of Arkansas' 75 counties were declared disaster areas as a result of flood and tornado damage in early December. Damage estimates exceeded 350 million dollars. The peak stage of December 3 on Buffalo River near St. Joe (see table on page 6) was 3.25 feet higher than that of the historic flood of August 1915 and the monthly mean flow of 8,865 cfs was highest for December in 43 years of record. (See graph on page 3.)

In Louisiana, monthly mean flows increased sharply at all index stations and were highest of record for

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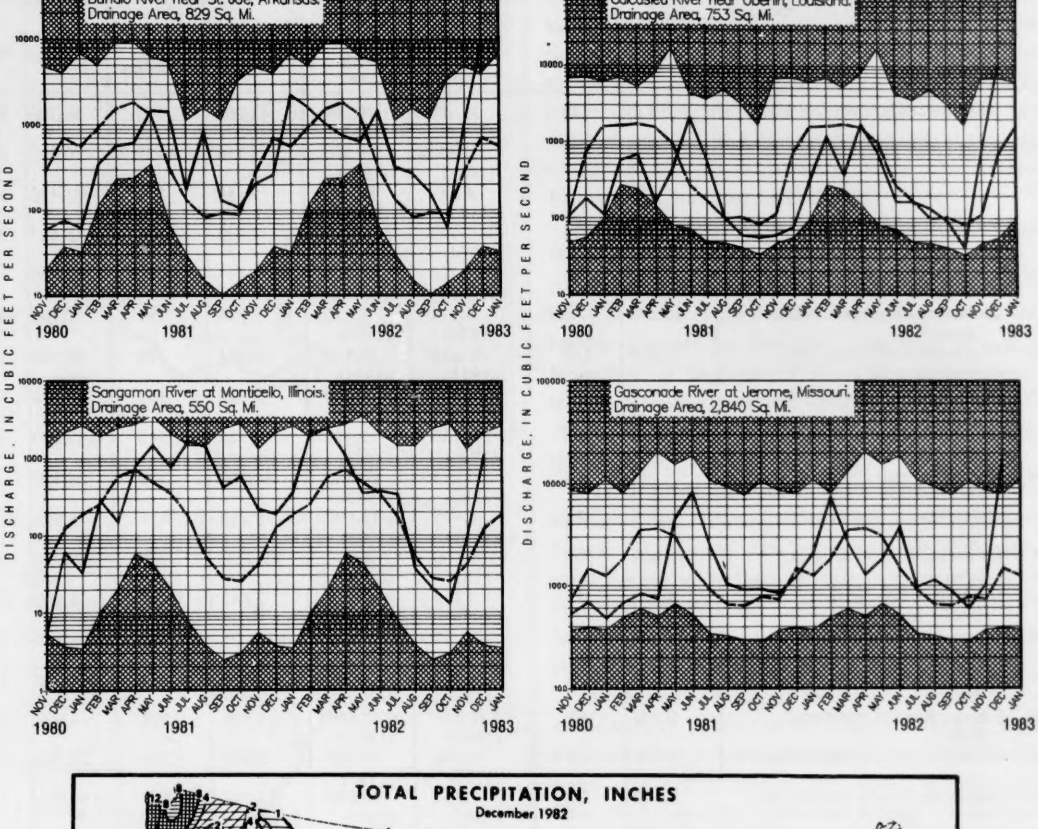
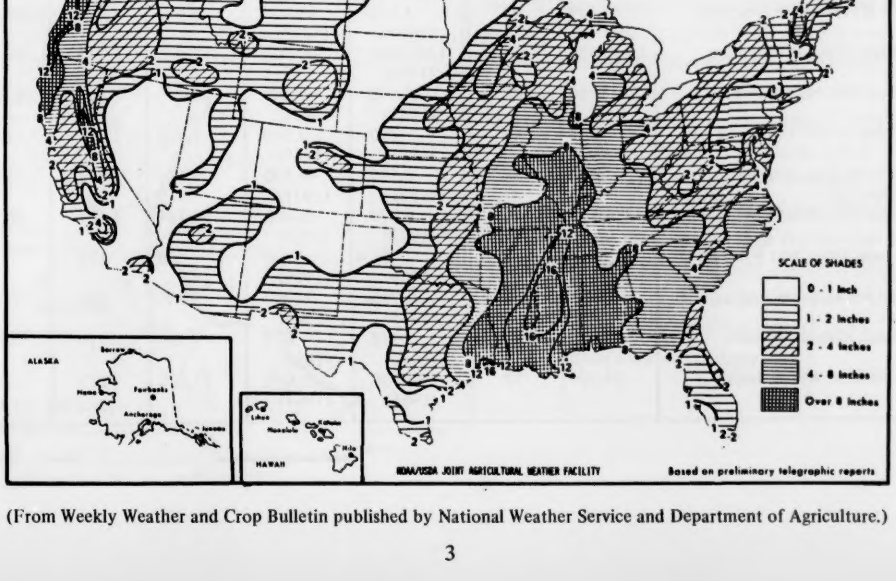
### CONTENTS

## SURFACE WATER – MONTHLY MEAN DISCHARGE IN KEY STREAMS

Unshaded area indicates range between highest and lowest record for the month. Dashed line indicates median of monthly values for reference period, 1951–80. Heavy line indicates mean for current period.

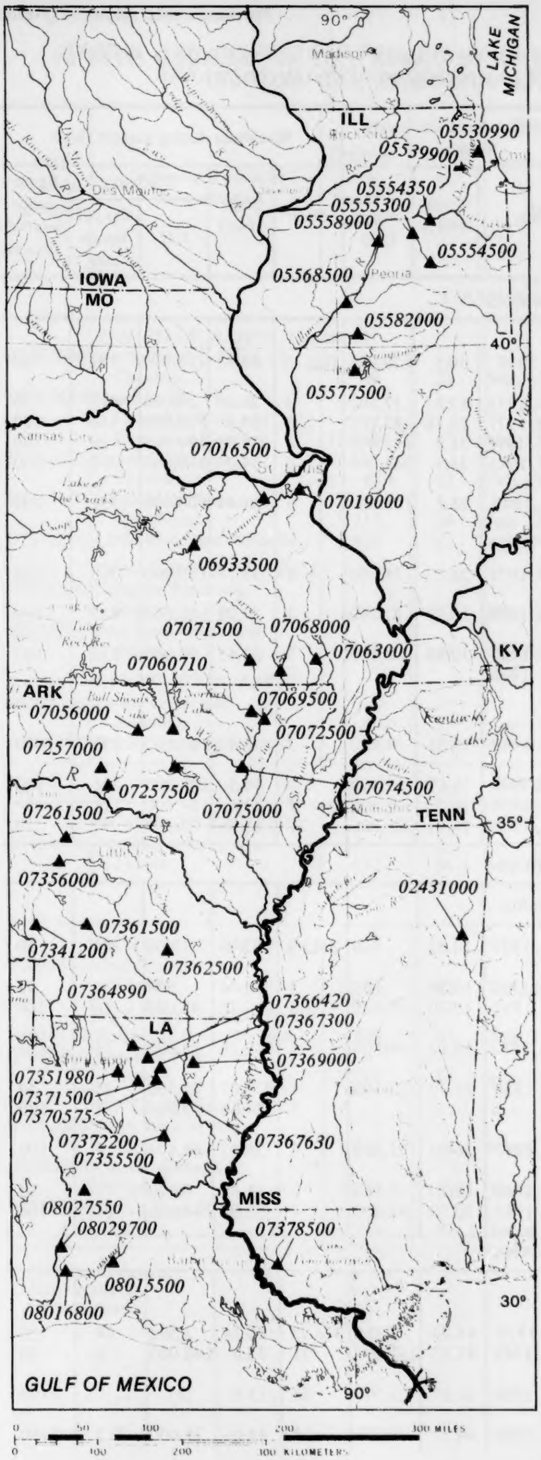



(From Weekly Weather and Crop Bulletin published by National Weather Service and Department of Agriculture.)

## *NEW EXTREMES DURING DECEMBER 1982 AT STREAMFLOW INDEX STATIONS*

| Station number | Stream and place of determination | Drainage area (square miles) | Years of record | Maximum December means (period of record) | | December 1982 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Monthly mean in cfs (year) | Daily mean in cfs (year) | Monthly mean in cfs | Percent of median | Daily mean in cfs | Day |
| 2489500 | Pearl River near Bogalusa, La . . . | 6,630 | 44 | 35,690 (1961) | 70,800 (1961) | 43,600 | 795 | 56,300 | 30 |
| 3380500 | Skillet Fork at Wayne City, Ill. . . | 464 | 71 | 2,953 (1967) | 19,400 (1967) | 3,356 | 1,422 | 20,000 | 27 |
| 3604500 | Buffalo River near Lobelville, Tenn. | 707 | 55 | 4,619 (1972) | 24,700 (1969) | 3,850 | 304 | 25,400 | 28 |
| 4071000 | Oconto River near Gillett, Wis. . . | 678 | 72 | 879 (1934) | 1,560 (1906) | 1,683 | 376 | 2,497 | 10 |
| 5280000 | Crow River at Rockford, Minn . . | 2,520 | 61 | 1,223 (1971) | 1,800 (1971) | 1,477 | 1,448 | 15,800 | 3 |
| 5330000 | Minnesota River near Jordan, Minn. | 16,200 | 48 | 4,131 (1970) | 5,730 (1970) | 5,178 | 794 | 7,100 | 6 |
| 5331000 | Mississippi River at St. Paul, Minn. | 36,800 | 112 | 13,610 (1971) | 20,100 (1951) | 16,074 | 331 | 25,100 | 1 |
| 5362000 | Jump River at Sheldon, Wis . . . . | 574 | 67 | 751 (1965) | 3,270 (1965) | 796 | 569 | 1,296 | 27 |
| 5435500 | Pecatonica River at Freeport, Ill. | 1,326 | 68 | 1,755 (1928) | 5,440 (1972) | 2,720 | 543 | 12,300 | 4 |
| 5446500 | Rock River near Joslin, Ill . . . . . | 9,542 | 43 | 9,713 (1980) | 18,000 (1942) | 14,900 | 318 | 25,100 | 7 |
| 5464500 | Cedar River at Cedar Rapids, Iowa. | 6,510 | 80 | 5,745 (1909) | 15,400 (1909) | 8,231 | 656 | 13,800 | 10 |
| 5474500 | Mississippi River at Keokuk, Iowa. | 119,000 | 104 | 109,600 (1881) | 136,000 (1881) | 125,600 | 345 | 179,900 | 5 |
| 5480500 | Des Moines River at Fort Dodge, Iowa. | 4,190 | 52 | 2,160 (1973) | 3,810 (1973) | 3,841 | 1,512 | 6,040 | 27 |
| 6354000 | Cannonball River at Breien, N. Dak. | 4,100 | 48 | 37.3 (1979) | 48 (1978) | 75 | 487 | 140 | 4 |
| 6485500 | Big Sioux River at Akron, Iowa. | 9,030 | 54 | 1,275 (1979) | 1,960 (1979) | 1,930 | 1,359 | 2,640 | 6 |
| 6800500 | Elkhorn River at Waterloo, Nebr. | 6,900 | 62 | 1,050 (1951) | 2,500 (1972) | 1,470 | 278 | 3,000 | 25 |
| 6897500 | Grand River near Gallatin, Mo. . . | 2,250 | 61 | 2,148 (1931) | 18,500 (1944) | 3,550 | 1,793 | 29,500 | 6 |
| 6933500 | Gasconade River at Jerome, Mo. . | 2,840 | 62 | 7,984 (1942) | 60,000 (1942) | 17,795 | 1,207 | 119,000 | 5 |
| 6934500 | Missouri River at Hermann, Mo . . | 528,200 | 85 | 127,400 (1973) | 277,000 (1942) | 180,950 | 447 | 361,000 | 4 |
| 7056000 | Buffalo River near St. Joe, Ark . . | 829 | 43 | 4,076 (1971) | 64,700 (1971) | 8,665 | 1,227 | 124,000 | 3 |
| 7289000 | Mississippi River at Vicksburg, Miss. | 1,140,500 | 54 | 1,064,000 (1972) | 1,300,000 (1972) | 1,145,900 | 242 | 1,399,000 | 19 |
| 7290000 | Big Black River near Bovina, Miss. | 2,810 | 46 | 25,730 (1961) | 63,100 (1961) | 28,442 | 937 | 48,200 | 31 |
| 7352000 | Saline Bayou near Lucky, La . . . | 154 | 42 | 790 (1961) | 3,860 (1940) | 1,200 | 1,314 | 7,210 | 28 |
| 7378500 | Amite River near Denham Springs, La. | 1,280 | 44 | 8,592 (1971) | 44,400 (1971) | 9,689 | 631 | 43,900 | 6 |
| 8013500 | Calcasieu River near Oberlin, La. | 753 | 46 | 6,879 (1923) | 26,000 (1923) | 10,344 | 1,467 | 50,700 | 30 |
| 9299500 | Whiterocks River near Whiterocks, Utah. | 113 | 72 | 61.4 (1909) | 70 (1909) | 56 | 175 | 73 | 2 |
| 9315000 | Green River at Green River, Utah. | 40,600 | 83 | 4,748 (1975) | 6,700 (1964) | 5,305 | 221 | 6,680 | 6 |
| 10322500 | Humboldt River at Palisade, Nev. | 5,010 | 75 | 312 (1950) | 675 (1964) | 319 | 371 | 415 | 23 |
| 13269000 | Snake River at Weiser, Idaho . . . | 69,200 | 72 | 24,950 (1964) | 69,600 (1964) | 27,500 | 177 | . . . . . . | . . . |




December. Widespread flooding occurred early in the month and again at monthend as a result of runoff from intense rains. The monthly mean flow of 10,344 cfs at Calcasieu River near Oberlin (drainage area, 753 square miles), in southwestern Louisiana, and the daily mean flow of 50,700 cfs on December 30 were highest for the month in 46 years of record and was typical of the extreme high flows that occurred during the month. (See graph on page 3.) Monthly mean discharges at the index streamflow stations in the State ranged between 6 and 15 times the December median flow.

In Illinois, floods with recurrence intervals of 50 to 100 years occurred on the Illinois River and some of its tributaries early in the month. Monthly and daily mean flows at 3 out of the 4 index streamflow stations were highest of record for December. (See table on page 4.) Mean flow of Sangamon River at Monticello increased sharply to over 9 times the median flow and was in the above-normal range for the first time since April 1982. (See graph on page 3.)

Flooding also occurred in parts of Indiana, western Kentucky and Tennessee, and Mississippi during the month. Preliminary data indicated peak discharges on some streams in northern Mississippi exceeded that of a 50-year flood as a result of runoff from rains of over 6 inches on Christmas Day. Some flash flooding occurred in western Kentucky early in the month.

In contrast to the many record high streamflows, key index stations in parts of the Atlantic Provinces, British Columbia, Saskatchewan, Hawaii, Kansas, South Carolina, Texas, and a large area in and adjacent to southeastern New York reported well-below average streamflow—within the lowest 25 percent of record. For example, flow of Massapequa Creek at Massapequa on Long Island, N. Y., was only 4.32 cfs, the third lowest December average flow in 47 years of record. Drought emergency measures continued in the Delaware River basin where streamflow and reservoir storage remained below average.

The combined flow of three large rivers—Mississippi, St. Lawrence, and Columbia—averaged 1,526,300 cfs during December, up 111% from last month and almost twice the long term median flow for the month. Because these three large rivers account for streamflow runoff for more than one-half of the conterminous United States, their combined flow provides a useful check on the status of the Nation's water resources.

## *STAGES AND DISCHARGES FOR THE FLOODS OF DECEMBER 1982 AT SELECTED SITES IN ARKANSAS, ILLINOIS, LOUISIANA, MISSISSIPPI, AND MISSOURI*

| WRD station number | Stream and place of determination | Drainage area (square miles) | Period of record (years) | Maximum flood previously known | | | Maximum during present flood | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Date | Stage (feet) | Discharge (cfs) | Date | Stage (feet) | Discharge | | Recurrence interval (years) |
| | | | | | | | | | Cfs | Cfs per square mile | |
| | **ARKANSAS** | | | | | | | | | | |
| | *WHITE RIVER BASIN* | | | | | | | | | | |
| 07056000 | Buffalo River near St. Joe . . | 829 | 43 | August 1915 | 50.5 | 129,000 | Dec. 3 | 53.75 | 158,000 | 191 | 80 |
| 07060710 | North Sylamore Creek near Fifty Six. | 58.1 | 16 | Apr. 22, 1973 | 17.61 | 17,800 | 3 | 20.60 | 24,000 | 413 | 25 |
| 07069500 | Spring River at Imboden . . . | 1,183 | 46 | Mar. 28, 1977 | 28.78 | 82,700 | 3 | 57.3 | 220,000 | 186 | 100 |
| 07072500 | Black River at Black Rock . . | 7,369 | 77 | Aug. 21, 1915 | 31.9 | 160,000 | 4 | 31.51 | 190,000 | 26 | >100 |
| 07074500 | White River at Newport . . . . | 19,800 | 49 | Apr. 17, 1945 | 35.9 | 343,000 | 6 | 34.0 | 260,000 | 13 | 100 |
| 07075000 | Middle Fork Little Red River at Shirley. | 302 | 43 | Jan. 24, 1949 | 28.3 | 101,000 | 3 | 31.44 | 100,000 | 331 | 100 |
| | *ARKANSAS RIVER BASIN* | | | | | | | | | | |
| 07257000 | Big Piney Creek near Dover. | 274 | 32 | Dec. 10, 1971 | 28.7 | 74,600 | 4 | 33.57 | 100,000 | 365 | >100 |
| 07257500 | Illinois Bayou near Scottsville. | 241 | 32 | Dec. 23, 1979 | 15.50 | 17,100 | 3 | 27.08 | 100,000 | 415 | >100 |
| 07261500 | Fourche Lafave River near Gravelly. | 410 | 43 | May 20, 1960<br>July 26, 1969 | 30.30 | 69,400 | 3 | 37.45 | 95,000 | 232 | 100 |
| | *RED RIVER BASIN* | | | | | | | | | | |
| 07341200 | Saline River near Lockesburg. | 256 | 19 | May 14, 1969 | 20.86 | 64,700 | 3 | 20.52 | 60,000 | 234 | 50 |
| 07356000 | Ouachita River near Mount Ida. | 414 | 44 | Dec. 10, 1971 | 38.62 | 95,500 | 3 | 40.50 | 102,000 | 246 | >100 |
| 07361500 | Antoine River at Antoine . . | 178 | 28 | May 2, 1958 | 28.75 | 35,500 | 7 | 23.5 | 34,000 | 191 | 50 |
| 07362500 | Mero Creek near Fordyce . . | 240 | 31 | May 2, 1958 | 16.47 | 26,800 | 27 | 15.95 | 22,200 | 92 | 50 |
| | **ILLINOIS** | | | | | | | | | | |
| | *ILLINOIS RIVER BASIN* | | | | | | | | | | |
| 05530990 | Salt Creek at Rolling Meadows. | 30.5 | 9 | Apr. 18, 1975 | 10.82 | 910 | Dec. 3 | 12.6 | 1,400 | 46 | 50 |
| 05539900 | West Branch DuPage River near West Chicago. | 28.5 | 22 | June 10, 1967 | 10.36 | 805 | 3 | 10.44 | 900 | 32 | 45 |
| 05543500 | Illinois River at Marseilles . . | 8,259 | 63 | July 14, 1957 | 15.20 | 93,900 | 5 | 16.78 | 95,000 | 10 | 100 |
| 05554500 | Vermillion River at Pontiac. | 579 | 40 | June 3, 1980 | 18.12 | 14,500 | 4 | 19.16 | 18,000 | 31 | >100 |
| 05555300 | Vermillion River near Leonore. | 1,251 | 51 | July 15, 1958 | 15.30 | 33,500 | 4 | [a]27.07 | 31,500 | 25 | 50 |
| 05558900 | Illinois River at Henry . . . . . | 13,551 | 1 | . . . . . . . . . . . | . . . . . | . . . . . . | 7 | 20.30 | 100,600 | 7 | 100 |
| 05568500 | Illinois River at Kingston Mines. | 15,819 | 43 | May 23, 1943 | 26.02 | 83,100 | 8 | 23.87 | 88,470 | 6 | 100 |
| 05577500 | Spring Creek at Springfield. | 107 | 33 | Mar. 30, 1960 | 12.70 | 6,750 | 3 | 14.55 | 7,820 | 73 | 50 |
| 05582000 | Salt Creek near Greenview . . | 1,804 | 41 | May 19, 1943 | 20.50 | 41,200 | 4 | 20.04 | 44,000 | 24 | 100 |
| | **LOUISIANA** | | | | | | | | | | |
| | *RED RIVER BASIN* | | | | | | | | | | |
| 07351980 | Saline Bayou near Beinville. | 54.9 | 15 | Jan. 21, 1979 | 44.74 | 2,210 | Dec. 27 | 45.24 | 3,500 | 64 | 50 |
| 07355500 | Red River at Alexandria . . . | 67,500 | 55 | Apr. 17, 1945 | 45.23 | 233,000 | 31 | 32.0 | 140,000 | 2 | 50 |
| 07364890 | Bayou D'Arbonne near Hico. | 254 | 2 | Apr. 14, 1980 | 13.87 | 3,500 | 28 | 15.9 | (b) | . . . . . . | >100 |
| 07366420 | Bayou Choudrant near Calhoun. | 113 | 16 | Feb. 10, 1966 | 44.72 | 9,170 | 28 | 48.06 | 24,000 | 212 | >100 |

## STAGES AND DISCHARGES FOR THE FLOODS OF DECEMBER 1982 AT SELECTED SITES IN ARKANSAS, ILLINOIS, LOUISIANA, MISSISSIPPI, AND MISSOURI—Continued

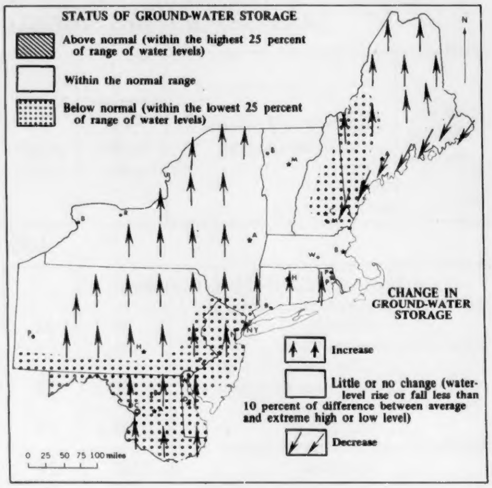
| WRD station number | Stream and place of determination | Drainage area (square miles) | Period of record (years) | Maximum flood previously known | | | Maximum during present flood | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Date | Stage (feet) | Discharge (cfs) | Date | Stage (feet) | Discharge | | Recurrence interval (years) |
| | | | | | | | | | Cfs | Cfs per square mile | |
| | **LOUISIANA—Continued** | | | | | | | | | | |
| | *RED RIVER BASIN*—Continued | | | | | | | | | | |
| 07367300 | North Cheniere Creek at Cheniere. | 38 | 22 | Mar. 21, 1955 | 45.89 | 6,270 | Dec.27 | 46.29 | 7,600 | 200 | >100 |
| 08367630 | Ouachita River at Columbia Rock and Dam, near Riverton. | 15,630 | 7 | May 13, 1979 | 43.08 | 71,000 | 27 | [c]37.0 | (b) | ...... | ...... |
| 07370575 | Caney Creek near Chatham. | 48.8 | 17 | Feb. 10, 1966 | 48.76 | 43,000 | 27 | 48.90 | 45,000 | 922 | >100 |
| 07371500 | Dugdemona River near Jonesboro. | 355 | 24 | Jan. 1, 1945 | 19.87 | 30,600 | 28 | 21.20 | (b) | ...... | >100 |
| 07372200 | Little River near Rochelle . . | 1,899 | 25 | Apr. 14, 1974 | 40.20 | 54,800 | 29 | 45.72 | 99,000 | 52 | >100 |
| | *CALCASIEU RIVER BASIN* | | | | | | | | | | |
| 08015500 | Calcasieu River near Kinder. | 1,700 | 42 | May 19, 1953 | 32.00 | 182,000 | 29 | 26.64 | 100,000 | 59 | 50 |
| 08016800 | Bear Head Creek near Starks. | 177 | 26 | May 18, 1980 | 17.70 | 11,500 | 29 | 18.25 | 13,000 | 73 | >100 |
| | *SABINE RIVER BASIN* | | | | | | | | | | |
| 08027550 | Prairie Creek near Leesville. | 40.0 | 27 | Apr. 31, 1953 | 47.68 | 8,400 | 27 | 48.11 | 9,500 | 238 | >100 |
| 08029700 | Brushy Creek at Bancroft . . | 25.9 | 21 | May 17, 1980 | 16.92 | 3,880 | 27 | 17.8 | 6,000 | 232 | >100 |
| | **MISSISSIPPI** | | | | | | | | | | |
| | *MOBILE RIVER BASIN* | | | | | | | | | | |
| 02431000 | Tombigbee River near Fulton. | 612 | 54 | Mar. 22, 1955 | 25.75 | 82,200 | Dec. 27 | 23.7 | 63,000 | 103 | 50 |
| | **MISSOURI** | | | | | | | | | | |
| | *GASCONADE RIVER BASIN* | | | | | | | | | | |
| 06933500 | Gasconade River at Jerome. | 2,840 | 62 | Jan. 6, 1897 | 29.0 | 120,000 | Dec. 5 | 31.34 | 140,000 | 49 | >100 |
| | *MERAMEC RIVER BASIN* | | | | | | | | | | |
| 07016500 | Bourbeuse River at Union . . | 808 | 61 | Aug. 22, 1915 | 28.5 | 50,000 | 5 | 33.6 | 70,100 | 87 | >100 |
| 07019000 | Meramec River near Eureka. | 3,788 | 63 | Aug. 22, 1915 | 42.2 | 175,000 | 6 | 42.88 | 145,000 | 38 | >100 |
| | *WHITE RIVER BASIN* | | | | | | | | | | |
| 07063000 | Black River at Poplar Bluff. | 1,245 | 44 | March 1904 | (b) | 100,000 | 5 | 21.68 | 45,000 | 36 | 100 |
| 07068000 | Current River at Doniphan. | 2,038 | 64 | March 1904 | 25.9 | 130,000 | 3 | 25.81 | 120,000 | 59 | >100 |
| 07071500 | Eleven Point River near Bardly. | 793 | 61 | August 1915 | 19.67 | 44,000 | 3 | 21.5 | 49,000 | 62 | 70–80 |

[a]Change in datum.
[b]Not available.
[c]Rising stage.

## GROUND-WATER CONDITIONS DURING DECEMBER 1982

In the northeastern States, ground-water levels continued to rise in most wells in northern and central Maine, and rose also in southern Connecticut and Rhode Island as well as in much of Maryland, New Jersey, New York, and Pennsylvania. Levels declined in coastal Maine and southeastern New Hampshire. (See map.) Levels near end of month were below average in western Maine and adjacent New Hampshire, and were below average also in Delaware, Maryland, New Jersey, and adjacent parts of Pennsylvania. Levels were at least slightly below average in many other parts of the region.

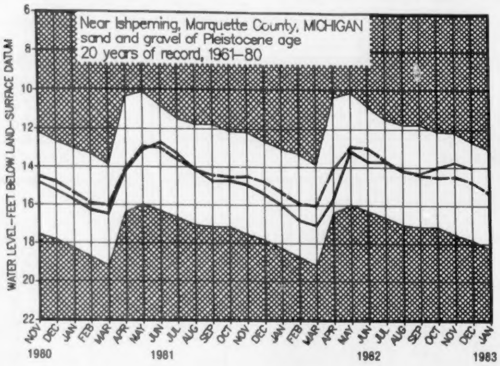
In the southeastern States, ground-water levels generally rose. However, levels declined in a few observation wells in North Carolina and Virginia. Levels were above average in much of the region, but were below average in Virginia and remained below average in observation wells in several heavily pumped aquifers in Arkansas, Florida, Louisiana, and Tennessee. A new high level for December occurred in Kentucky.

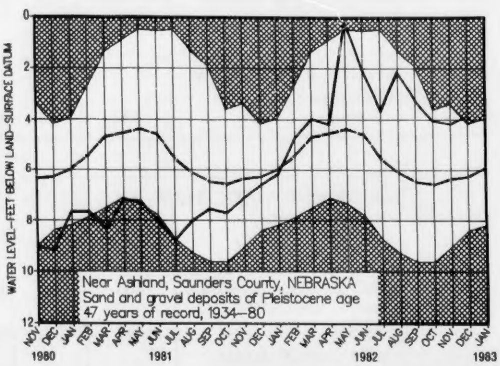


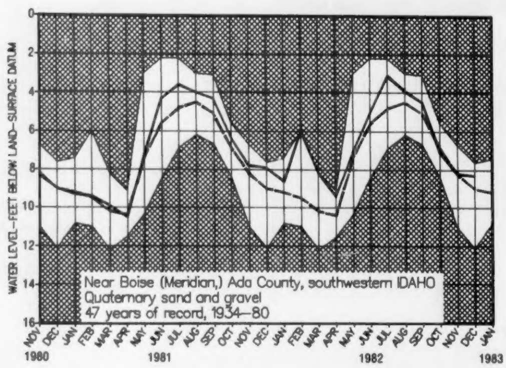

Map shows ground-water storage near end of December and change in ground-water storage from end of November to end of December.

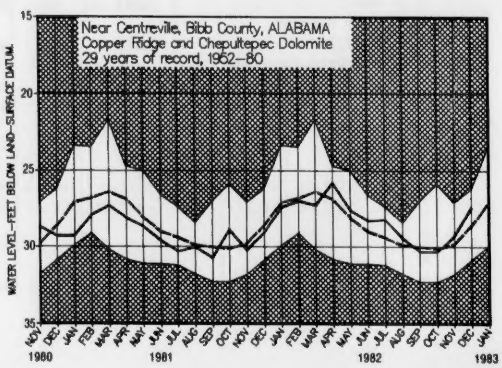
## MONTH-END GROUND-WATER LEVELS IN KEY WELLS

Unshaded area indicates range between highest and lowest record for the month. Dashed line indicates average of monthly levels in previous years. Heavy line indicates level for current period.



*WATER LEVELS IN KEY OBSERVATION WELLS IN SOME REPRESENTATIVE AQUIFERS IN THE CONTERMINOUS UNITED STATES—DECEMBER 1982*

| Aquifer and location | Current water level in feet below land-surface datum | Departure from average in feet | Net change in water level in feet since: | | Year records began | Remarks |
|---|---|---|---|---|---|---|
| | | | Last month | Last year | | |
| Glacial drift at Hanska, south-central Minnesota | -5.10 | +3.39 | -1.19 | -0.06 | 1943 | |
| Glacial drift at Roscommon in north-central part of Lower Peninsula, Michigan | -3.78 | +1.12 | +0.61 | +1.33 | 1935 | |
| Glacial drift at Marion, Iowa | -2.56 | +4.05 | -0.43 | +0.81 | 1941 | |
| Glacial drift at Princeton in northwestern Illinois | -6.42 | +7.49 | +2.06 | +3.24 | 1943 | |
| Petersburg Granite, southeastern Piedmont near Fall Zone, Colonial Heights, Virginia | -16.62 | -0.72 | -0.34 | +1.41 | 1939 | |
| Glacial outwash sand and gravel, Louisville, Kentucky | -18.90 | +7.30 | -0.12 | -0.41 | 1946 | |
| 500-foot sand aquifer near Memphis, Tennessee (U.S. well no. 2) | -102.93 | -14.79 | +0.37 | +0.76 | 1941 | |
| Granite in eastern Piedmont Province, Chapel Hill, North Carolina | -42.22 | +1.44 | -0.26 | +3.86 | 1931 | |
| Sparta Sand in Pine Bluff industrial area, Arkansas | -236.15 | -33.33 | -6.15 | +7.30 | 1958 | |
| Copper Ridge and Chepultepec Dolomites, Centreville, Alabama | -27.4 | +1.2 | +1.9 | +1.7 | 1952 | |
| Limestone aquifer on Cockspur Island, Savannah area, Georgia | -23.10 | -5.00 | +0.20 | +1.30 | 1956 | |
| Sand and gravel in Puget Trough, Tacoma, Washington | -104.01 | +7.11 | +0.27 | +1.49 | 1952 | |
| Pleistocene glacial outwash gravel, North Pole, northern Idaho (U.S. well no. 3) | -458.5 | +3.2 | -0.5 | +7.7 | 1929 | |
| Snake River Group: southwestern Snake River Plain aquifer, at Eden, Idaho | -124.6 | -8.0 | -1.4 | +1.1 | 1957 | |
| Alluvial sand and gravel, Platte River Valley, Nebraska (U.S. well no. 6) | -3.85 | +2.44 | +0.35 | +2.75 | 1935 | December high. |
| Ogallala Formation, Kansas Agricultural Experiment Station at Colby in the High Plains of northwestern Kansas | -124.55 | -7.18 | +0.31 | +0.06 | 1947 | |
| Alluvium and Paso Robles, clay, sand, and gravel, Santa Maria Valley, California | -136.82 | +11.38 | +1.33 | -2.69 | 1957 | |
| Valley fill, Elfrida area, Douglas, Arizona (U.S. well no. 15) | -111.5 | -34.74 | +1.3 | -0.7 | 1951 | |
| Berrendo-Smith well in San Andres Limestone, Roswell artesian basin of Pecos Valley, New Mexico (U.S. well no. 1-A) | -57.38 | +0.11 | +1.91 | -1.44 | 1966 | |
| Hueco bolson, El Paso area, Texas | -259.69 | -16.18 | +0.12 | -2.13 | 1965 | December low. |
| Evangeline aquifer, Houston area, Texas | -333.02 | -34.35 | +0.98 | -14.93 | 1965 | December low. |

In the central and western Great Lakes States, levels generally rose except for declining levels in parts of Minnesota. Levels were above average in most observation wells, but remained below average in northeastern Ohio. A new high water level for December occurred in Iowa and levels were near record highs in parts of Indiana.

In the West, levels rose in most observation wells. However, trends were mixed in Arizona, Idaho, and Utah. Patterns were mixed also in terms of averages for end of December; but above-average levels predominated in observation wells in Nebraska, North Dakota, and Washington; and below-average levels predominated in Arizona, Kansas, and Texas. New high water levels for December were recorded in Nebraska and North Dakota and new lows for December occurred in Arizona and Texas.

## *USABLE CONTENTS OF SELECTED RESERVOIRS NEAR END OF DECEMBER 1982*

[Contents are expressed in percent of reservoir capacity. The usable storage capacity of each reservoir is shown in the column headed "Normal maximum."]

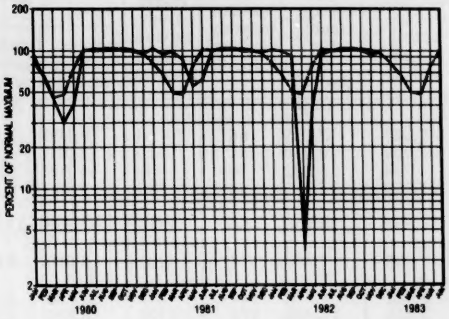
| Reservoir<br>Principal uses:<br>F–Flood control<br>I–Irrigation<br>M–Municipal<br>P–Power<br>R–Recreation<br>W–Industrial | Percent of normal maximum | | | | Normal maximum (acre-feet)[a] |
|---|---|---|---|---|---|
| | End of Dec. 1982 | End of Dec. 1981 | Average for end of Dec. | End of Nov. 1982 | |
| *NORTHEAST REGION* | | | | | |
| **NOVA SCOTIA** | | | | | |
| Rossignol, Mulgrave, Falls Lake, St. Margaret's Bay, Black, and Ponhook Reservoirs (P) | 33 | 73 | 50 | 28 | [b]226,300 |
| **QUEBEC** | | | | | |
| Allard (P) | 94 | 84 | 58 | 87 | 280,600 |
| Gouin (P) | 57 | 60 | 65 | 54 | 6,954,000 |
| **MAINE** | | | | | |
| Seven reservoir systems (MP) | 57 | 84 | 57 | 56 | 4,098,000 |
| **NEW HAMPSHIRE** | | | | | |
| First Connecticut Lake (P) | 54 | 57 | 58 | 72 | 76,450 |
| Lake Francis (FPR) | 95 | 71 | 69 | 77 | 99,310 |
| Lake Winnipesaukee (PR) | 61 | 75 | 61 | 65 | 165,700 |
| **VERMONT** | | | | | |
| Harriman (P) | 67 | 64 | 59 | 65 | 116,200 |
| Somerset (P) | 71 | 64 | 66 | 65 | 57,390 |
| **MASSACHUSETTS** | | | | | |
| Cobble Mountain and Borden Brook (MP) | 71 | 70 | 72 | 73 | 77,920 |
| **NEW YORK** | | | | | |
| Great Sacandaga Lake (FPR) | 48 | 39 | 52 | 46 | 786,700 |
| Indian Lake (FMP) | 66 | 73 | 61 | 65 | 103,300 |
| New York City reservoir system (MW) | 53 | 62 | ... | 51 | 1,680,000 |
| **NEW JERSEY** | | | | | |
| Wanaque (M) | 66 | 47 | 70 | 66 | 85,100 |
| **PENNSYLVANIA** | | | | | |
| Allegheny (FPR) | 71 | 38 | 30 | 58 | 1,180,000 |
| Pymatuning (FMR) | 93 | 93 | 81 | 92 | 188,000 |
| Raystown Lake (FR) | 67 | 70 | 50 | 66 | 761,900 |
| Lake Wallenpaupack (PR) | 68 | 52 | 56 | 66 | 157,800 |
| **MARYLAND** | | | | | |
| Baltimore municipal system (M) | 64 | 64 | 84 | 65 | 255,800 |
| *SOUTHEAST REGION* | | | | | |
| **NORTH CAROLINA** | | | | | |
| Bridgewater (Lake James) (P) | 93 | 83 | 76 | 92 | 288,800 |
| Narrows (Badin Lake) (P) | 85 | 80 | 94 | 95 | 128,900 |
| High Rock Lake (P) | 56 | 49 | 61 | 42 | 234,800 |
| **SOUTH CAROLINA** | | | | | |
| Lake Murray (P) | 86 | 87 | 60 | 83 | 1,614,000 |
| Lakes Marion and Moultrie (P) | 73 | 72 | 59 | 75 | 1,862,000 |
| **SOUTH CAROLINA--GEORGIA** | | | | | |
| Clark Hill (FP) | 67 | 44 | 51 | 61 | 1,730,000 |
| **GEORGIA** | | | | | |
| Burton (PR) | 86 | 77 | 51 | 92 | 104,000 |
| Sinclair (MPR) | 95 | 87 | 72 | 91 | 214,000 |
| Lake Sidney Lanier (FMPR) | 63 | 28 | 50 | 58 | 1,686,000 |
| **ALABAMA** | | | | | |
| Lake Martin (P) | 81 | 74 | 59 | 85 | 1,373,000 |
| **TENNESSEE VALLEY** | | | | | |
| Clinch Projects: Norris and Melton Hill Lakes (FPR) | 39 | 35 | 31 | 34 | 2,229,300 |
| Douglas Lake (FPR) | 22 | 14 | 10 | 26 | 1,394,000 |
| Hiwassee Projects: Chatuge, Nottely, Hiwassee, Apalachia, Blue Ridge, Ocoee 3, and Parksville Lakes (FPR) | 52 | 43 | 37 | 49 | 1,012,000 |
| Holston Projects: South Holston, Watauga, Boone, Fort Patrick Henry, and Cherokee Lakes (FPR) | 48 | 39 | 31 | 46 | 2,880,000 |
| Little Tennessee Projects: Nantahala, Thorpe, Fontana, and Chilhowee Lakes (FPR) | 54 | 46 | 37 | 50 | 1,478,000 |
| *WESTERN GREAT LAKES REGION* | | | | | |
| **WISCONSIN** | | | | | |
| Chippewa and Flambeau (PR) | 79 | 56 | 62 | 98 | 365,000 |
| Wisconsin River (21 reservoirs) (PR) | 85 | 44 | 52 | 95 | 399,000 |
| **MINNESOTA** | | | | | |
| Mississippi River headwater system (FMR) | 26 | 26 | 23 | 30 | 1,640,000 |
| *MIDCONTINENT REGION* | | | | | |
| **NORTH DAKOTA** | | | | | |
| Lake Sakakawea (Garrison) (FIPR) | 88 | 75 | 84 | 89 | 22,700,000 |
| **SOUTH DAKOTA** | | | | | |
| Angostura (I) | 88 | 53 | 72 | 87 | 127,600 |
| Belle Fourche (I) | 85 | 34 | 43 | 79 | 185,200 |
| Lake Francis Case (FIP) | 55 | 55 | 56 | 50 | 4,834,000 |
| Lake Oahe (FIP) | 85 | 65 | ... | 86 | 22,530,000 |
| *MIDCONTINENT REGION*—Continued | | | | | |
| **SOUTH DAKOTA**—Continued | | | | | |
| Lake Sharpe (FIP) | 99 | 101 | 95 | 100 | 1,725,000 |
| Lewis and Clarke Lake (FIP) | 76 | 91 | 92 | 96 | 477,000 |
| **NEBRASKA** | | | | | |
| Lake McConaughy (IP) | 81 | 78 | 70 | 80 | 1,948,000 |
| **OKLAHOMA** | | | | | |
| Eufaula (FPR) | 89 | 90 | 82 | 81 | 2,378,000 |
| Keystone (FPR) | 80 | 85 | 92 | 76 | 661,000 |
| Tenkiller Ferry (FPR) | 106 | 96 | 90 | 90 | 628,200 |
| Lake Altus (FIMR) | 53 | 12 | 48 | 55 | 133,000 |
| Lake O'The Cherokees (FPR) | 93 | 94 | 79 | 82 | 1,492,000 |
| **OKLAHOMA--TEXAS** | | | | | |
| Lake Texoma (FMPRW) | 90 | 92 | 89 | 89 | 2,722,000 |
| **TEXAS** | | | | | |
| Bridgeport (IMW) | 87 | 100 | 44 | 87 | 386,400 |
| Canyon (FMR) | 94 | 95 | 74 | 93 | 385,600 |
| International Amistad (FIMPW) | 88 | 108 | 86 | 88 | 3,497,000 |
| International Falcon (FIMPW) | 76 | 103 | 79 | 74 | 2,668,000 |
| Livingston (IMW) | 103 | 101 | 82 | 100 | 1,788,000 |
| Possum Kingdom (IMPRW) | 88 | 93 | 98 | 88 | 570,200 |
| Red Bluff (PI) | 16 | 18 | 29 | 15 | 307,000 |
| Toledo Bend (P) | 99 | 90 | 80 | 86 | 4,472,000 |
| Twin Buttes (FIM) | 37 | 51 | 31 | 37 | 177,800 |
| Lake Kemp (IMW) | 83 | 58 | 84 | 81 | 268,000 |
| Lake Meredith (FWM) | 51 | 36 | 37 | 50 | 796,900 |
| Lake Travis (FIMPRW) | 77 | 99 | 78 | 77 | 1,144,000 |
| *THE WEST* | | | | | |
| **WASHINGTON** | | | | | |
| Ross (PR) | 84 | 71 | 69 | 84 | 1,052,000 |
| Franklin D. Roosevelt Lake (IP) | 97 | 101 | 95 | 93 | 5,022,000 |
| Lake Chelan (PR) | 54 | 61 | 55 | 68 | 676,100 |
| Lake Cushman (PR) | 47 | 84 | 85 | 45 | 359,500 |
| Lake Merwin (P) | 98 | 98 | 94 | 100 | 245,600 |
| **IDAHO** | | | | | |
| Boise River (4 reservoirs) (FIP) | 72 | 58 | 57 | 71 | 1,235,000 |
| Coeur d'Alene Lake (P) | 48 | 43 | 56 | 41 | 238,500 |
| Pend Oreille Lake (FP) | 52 | 34 | 50 | 52 | 1,561,000 |
| **IDAHO--WYOMING** | | | | | |
| Upper Snake River (8 reservoirs) (MP) | 73 | 52 | 62 | 74 | 4,401,000 |
| **WYOMING** | | | | | |
| Boysen (FIP) | 83 | 77 | 74 | 93 | 802,000 |
| Buffalo Bill (IP) | 87 | 54 | 67 | 93 | 421,300 |
| Keyhole (F) | 31 | 21 | 44 | 30 | 193,800 |
| Pathfinder, Seminoe, Alcova, Kortes, Glendo, and Guernsey Reservoirs (I) | 56 | 43 | 46 | 54 | 3,056,000 |
| **COLORADO** | | | | | |
| John Martin (FIR) | 10 | 7 | 13 | 6 | 364,400 |
| Taylor Park (IR) | 68 | 44 | 53 | 69 | 106,200 |
| Colorado–Big Thompson project (I) | 56 | 45 | 55 | 56 | 722,600 |
| **COLORADO RIVER STORAGE PROJECT** | | | | | |
| Lake Powell; Flaming Gorge, Fontenelle, Navajo, and Blue Mesa Reservoirs (IFPR) | 89 | 78 | ... | 91 | 31,620,000 |
| **UTAH--IDAHO** | | | | | |
| Bear Lake (IPR) | 83 | 62 | 57 | 84 | 1,421,000 |
| **CALIFORNIA** | | | | | |
| Folsom (FIP) | 70 | 77 | 52 | 66 | 1,000,000 |
| Hetch Hetchy (MP) | 83 | 54 | 36 | 94 | 360,400 |
| Isabella (FIR) | 46 | 29 | 24 | 47 | 568,100 |
| Pine Flat (FI) | 66 | 43 | 45 | 72 | 1,001,000 |
| Clair Engle Lake (Lewiston) (P) | 83 | 86 | 72 | 82 | 2,438,000 |
| Lake Almanor (P) | 88 | 85 | 48 | 87 | 1,036,000 |
| Lake Berryessa (FIMW) | 96 | 77 | 76 | 90 | 1,600,000 |
| Millerton Lake (FI) | 73 | 57 | 53 | 71 | 503,200 |
| Shasta Lake (FIPR) | 78 | 85 | 67 | 76 | 4,377,000 |
| **CALIFORNIA--NEVADA** | | | | | |
| Lake Tahoe (IPR) | 83 | 45 | 47 | 85 | 744,600 |
| **NEVADA** | | | | | |
| Rye Patch (I) | 86 | 29 | 51 | 78 | 194,300 |
| **ARIZONA--NEVADA** | | | | | |
| Lake Mead and Lake Mohave (FIMP) | 92 | 87 | 69 | 90 | 27,970,000 |
| **ARIZONA** | | | | | |
| San Carlos (IP) | 14 | 23 | 16 | 8 | 1,073,000 |
| Salt and Verde River system (IMPR) | 78 | 53 | 37 | 66 | 2,073,000 |
| **NEW MEXICO** | | | | | |
| Conchas (FIR) | 73 | 46 | 79 | 72 | 330,100 |
| Elephant Butte and Caballo (FIPR) | 39 | 34 | 29 | 38 | 2,453,000 |

[a]1 acre-foot = 0.0436 million cubic feet = 0.326 million gallons = 0.504 cubic feet per second day.
[b]Thousands of kilowatt-hours (the potential electric power that could be generated by the volume of water in storage).

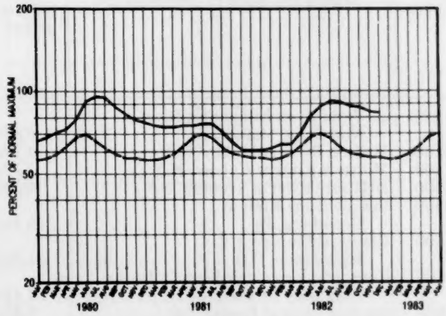
## USABLE CONTENTS OF SELECTED RESERVOIRS AND RESERVOIR SYSTEMS, JANUARY 1980 TO DECEMBER 1982

Dashed line indicates average of month-end contents. Solid line indicates current period.

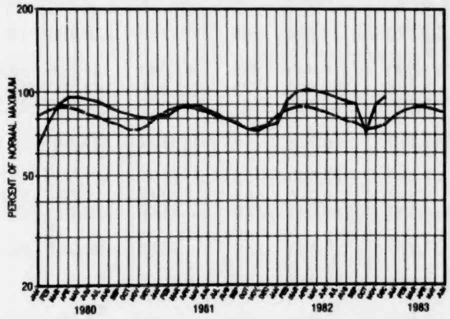
Franklin D. Roosevelt Lake, Washington
Normal Maximum, 5,022,000 acre-feet



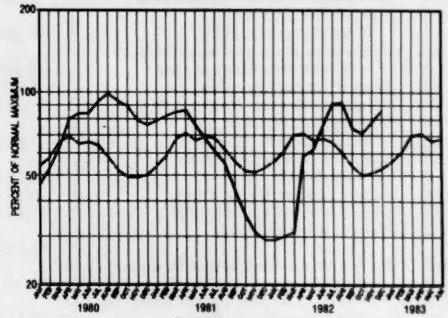

Bear Lake, Utah
Normal Maximum, 1,421,000 acre-feet



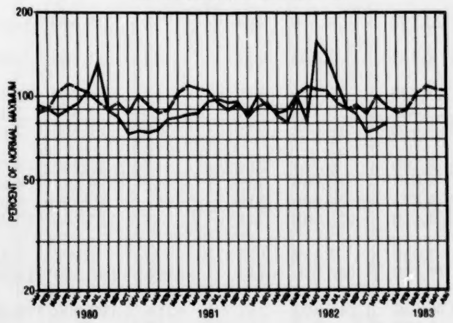

Lake Berryessa, California
Normal Maximum, 1,600,000 acre-feet



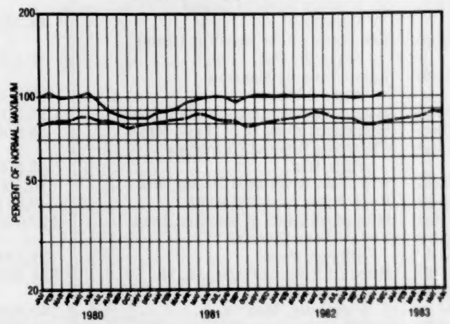

Rye Patch, Nevada
Normal Maximum, 194,300 acre-feet



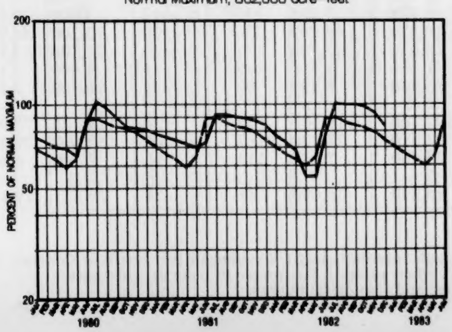

Keystone, Oklahoma
Normal Maximum, 661,000 acre-feet



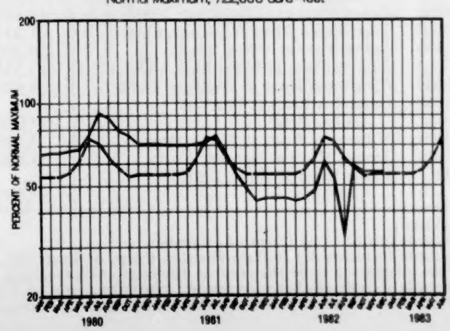

Livingston, Texas
Normal Maximum, 1,788,000 acre-feet




Boysen, Wyoming
Normal Maximum, 802,000 acre-feet




Colorado–Big Thompson Project, Colorado
Normal Maximum, 722,600 acre-feet



Provisional data; subject to revision

## *FLOW OF LARGE RIVERS DURING DECEMBER 1982*

| Station number | Stream and place of determination | Drainage area (square miles) | Mean annual discharge through September 1980 (cubic feet per second) | December 1982: Monthly mean discharge (cubic feet per second) | Percent of median monthly discharge, 1951–80 | Change in discharge from pervious month (percent) | Discharge near end of month: Cubic feet per second | Discharge near end of month: Million gallons per day | Date |
|---|---|---|---|---|---|---|---|---|---|
| 01014000 | St. John River below Fish River at Fort Kent, Maine | 5,690 | 9,647 | 8,125 | 166 | -4 | 9,100 | 5,880 | 31 |
| 01318500 | Hudson River at Hadley, N.Y | 1,664 | 2,909 | 2,010 | 81 | -20 | 2,010 | 1,299 | 31 |
| 01357500 | Mohawk River at Cohoes, N.Y | 3,456 | 5,734 | 3,880 | 74 | +60 | 4,700 | 3,040 | 31 |
| 01463500 | Delaware River at Trenton, N.J | 6,780 | 11,750 | 6,713 | 58 | +32 | 9,640 | 6,230 | 31 |
| 01570500 | Susquehanna River at Harrisburg, Pa | 24,100 | 34,530 | 19,100 | 56 | +111 | 37,100 | 23,980 | 30 |
| 01646500 | Potomac River near Washington, D.C. | 11,560 | [1] 11,490 | 7,280 | 73 | +121 | 14,000 | 9,000 | 20 |
| 02105500 | Cape Fear River at William O. Huske Lock near Tarheel, N.C. | 4,810 | 5,005 | 5,570 | 144 | +271 | 2,700 | 1,750 | 29 |
| 02131000 | Pee Dee River at Peedee, S.C | 8,830 | 9,851 | 13,000 | 174 | +127 | 10,800 | 6,980 | 29 |
| 02226000 | Altamaha River at Doctortown, Ga | 13,600 | 13,880 | 12,280 | 155 | +199 | 15,700 | 10,150 | 30 |
| 02320500 | Suwannee River at Branford, Fla | 7,880 | 6,987 | 2,830 | 88 | 0 | 3,030 | 1,958 | 31 |
| 02358000 | Apalachicola River at Chattahoochee, Fla | 17,200 | 22,570 | 34,800 | 205 | +168 | 28,400 | 18,360 | 31 |
| 02467000 | Tombigbee River at Demopolis lock and dam near Coatopa, Ala | 15,400 | 23,300 | 74,000 | 363 | +1,084 | 86,000 | 55,600 | 31 |
| 02489500 | Pearl River near Bogalusa, La | 6,630 | 9,768 | 43,600 | 795 | +1,671 | 40,800 | 26,370 | 31 |
| 03049500 | Allegheny River at Natrona, Pa | 11,410 | [1] 19,480 | 26,561 | 101 | +76 | 40,800 | 26,370 | 29 |
| 03085000 | Monongahela River at Braddock, Pa. | 7,337 | [1] 12,510 | 16,376 | 110 | +103 | 23,200 | 14,990 | 28 |
| 03193000 | Kanawha River at Kanawha Falls, W. Va | 8,367 | 12,590 | 18,600 | 135 | +134 | 11,800 | 7,630 | 24 |
| 03234500 | Scioto River at Higby, Ohio | 5,131 | 4,547 | 6,014 | 148 | +223 | 17,100 | 11,050 | 30 |
| 03294500 | Ohio River at Louisville, Ky[2] | 91,170 | 116,000 | 154,600 | 119 | +168 | 220,400 | 142,450 | 26 |
| 03377500 | Wabash River at Mount Carmel, Ill | 28,635 | 27,220 | 60,880 | 265 | +329 | 106,000 | 68,500 | 31 |
| 03469000 | French Broad River below Douglas Dam, Tenn | 4,543 | 6,798 | 12,773 | 195 | +145 | ...... | ...... | ... |
| 04084500 | Fox River at Rapide Croche Dam, near Wrightstown, Wis[2] | 6,150 | 4,163 | 2,910 | 81 | -11 | 3,316 | 2,143 | 19 |
| 04264331 | St. Lawrence River at Cornwall, Ontario–near Massena, N.Y[3] | 299,000 | 242,700 | 270,060 | 113 | +1 | 255,000 | 164,800 | 31 |
| 050115 | St. Maurice River at Grand Mere, Quebec | 16,300 | 25,150 | 24,500 | 184 | -8 | 19,600 | 12,670 | 30 |
| 05082500 | Red River of the North at Grand Forks, N. Dak | 30,100 | 2,551 | 2,000 | 174 | -29 | 1,560 | 1,008 | 27 |
| 05133500 | Rainy River at Manitou Rapids, Minn. | 19,400 | 12,830 | 20,700 | 211 | -11 | 14,900 | 9,630 | 31 |
| 05330000 | Minnesota River near Jordan, Minn. | 16,200 | 3,402 | 5,178 | 794 | -20 | 4,850 | 3,134 | 30 |
| 05331000 | Mississippi River at St. Paul, Minn | 36,800 | [1] 10,610 | 16,074 | 331 | -10 | 11,800 | 7,630 | 30 |
| 05365500 | Chippewa River at Chippewa Falls, Wis | 5,600 | 5,100 | 6,745 | 214 | -42 | 12,940 | 8,363 | 28 |
| 05407000 | Wisconsin River at Muscoda, Wis | 10,300 | 8,617 | 10,699 | 165 | -32 | 6,877 | 4,444 | 27 |
| 05446500 | Rock River near Joslin, Ill | 9,551 | 5,873 | 14,900 | 318 | +64 | 12,500 | 8,080 | 31 |
| 05474500 | Mississippi River at Keokuk, Iowa | 119,000 | 62,620 | 125,600 | 345 | +6 | 113,700 | 73,490 | 31 |
| 06214500 | Yellowstone River at Billings, Mont | 11,796 | 7,038 | 3,419 | 113 | -20 | 2,800 | 1,810 | 31 |
| 06934500 | Missouri River at Hermann, Mo | 524,200 | 79,490 | 180,950 | 447 | +120 | 180,000 | 116,000 | 31 |
| 07289000 | Mississippi River at Vicksburg, Miss[4] | 1,140,500 | 576,600 | 1,145,900 | 242 | +214 | 1,192,000 | 770,400 | 27 |
| 07331000 | Washita River near Dickson, Okla. | 7,202 | 1,368 | 443 | 114 | +67 | 360 | 232 | 31 |
| 08276500 | Rio Grande below Taos Junction Bridge, near Taos, N. Mex | 9,730 | 725 | 506 | 119 | -27 | 370 | 239 | 31 |
| 09315000 | Green River at Green River, Utah. | 40,600 | 6,298 | 5,305 | 221 | -17 | 3,000 | 1,900 | 30 |
| 11425500 | Sacramento River at Verona, Calif | 21,257 | 18,820 | 48,939 | 236 | +90 | 72,700 | 46,990 | 24 |
| 13269000 | Snake River at Weiser, Idaho | 69,200 | 18,050 | 27,500 | 177 | +20 | 27,500 | 17,770 | 27 |
| 13317000 | Salmon River at White Bird, Idaho | 13,550 | 11,250 | 5,710 | 123 | -15 | 4,840 | 3,128 | 28 |
| 13342500 | Clearwater River at Spalding, Idaho | 9,570 | 15,480 | 6,130 | 97 | +31 | 11,000 | 7,100 | 28 |
| 14105700 | Columbia River at The Dalles, Oreg[5] | 237,000 | 193,100 | 110,300 | 128 | +20 | 114,400 | 73,940 | 26 |
| 14191000 | Willamette River at Salem, Oreg. | 7,280 | 23,510 | 72,700 | 167 | +305 | 60,500 | 39,100 | 26 |
| 15515500 | Tanana River at Nenana, Alaska. | 25,600 | 23,460 | 7,684 | 114 | -16 | 7,200 | 4,650 | 25 |
| 8MF005 | Fraser River at Hope, British Columbia | 83,800 | 96,290 | 38,488 | 87 | -25 | 29,625 | 19,147 | 30 |

[1] Adjusted.
[2] Records furnished by Corps of Engineers.
[3] Records furnished by Buffalo District, Corps of Engineers, through International St. Lawrence River Board of Control. Discharges shown are considered to be the same as discharge at Ogdensburg, N.Y. when adjusted for storage in Lake St. Lawrence.
[4] Records of daily discharge computed jointly by Corps of Engineers and Geological Survey.
[5] Discharge determined from information furnished by Bureau of Reclamation, Corps of Engineers, and Geological Survey.

Provisional data; subject to revision

## DISSOLVED SOLIDS AND WATER TEMPERATURES FOR DECEMBER AT DOWNSTREAM SITES ON SIX LARGE RIVERS

| Station number | Station name | December data of following calendar years | Stream discharge during month | Dissolved-solids concentration during month[a] | | Dissolved-solids discharge during month[a] | | | Water temperature during month[b] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Mean (cfs) | Minimum (mg/L) | Maximum (mg/L) | Mean (tons per day) | Minimum (tons per day) | Maximum (tons per day) | Mean in°C | Minimum, in°C | Maximum, in°C |
| | *NORTHEAST* | | | | | | | | | | |
| 01463500 | Delaware River at | 1982 | 6,810 | 87 | 128 | 1,900 | 1,055 | 3,140 | 5.5 | 1.5 | 12.0 |
| | Trenton, N.J. | 1945–81 | 12,950 | 65 | 138 | ...... | 631 | 20,500 | ... | 0 | 11.0 |
| | (Morrisville, Pa.) | (Extreme yr) | | (1949) | (1980) | | (1964) | (1973) | | | |
| | | | [c]11,650 | | | | | | | | |
| 04264331 | St. Lawrence River at | 1982 | 271,000 | 165 | 167 | 121,000 | 116,000 | 126,000 | 5.0 | 3.0 | 7.5 |
| | Cornwall, Ontario, near | 1975–81 | 260,400 | 163 | 170 | 117,000 | 13,100 | 139,000 | 3.0 | 0.5 | 8.0 |
| | Massena, N.Y. | (Extreme yr) | | (1978) | (1975) | | (1979) | (1981) | | | |
| | median streamflow at | | [c]239,200 | | | | | | | | |
| | Ogdensburg, N.Y. | | | | | | | | | | |
| | *SOUTHEAST* | | | | | | | | | | |
| 0728900 | Mississippi River at | 1982 | *1,146,000 | 174 | 255 | 609,000 | 419,000 | 683,000 | ... | ... | ... |
| | Vicksburg, Miss. | 1975–81 | 565,200 | 153 | 295 | 317,000 | 131,000 | 511,000 | 8.0 | 3.5 | 13.0 |
| | | (Extreme yr) | | (1978) | (1980) | | (1976) | (1979) | | | |
| | | | [c]472,850 | | | | | | | | |
| | *WESTERN GREAT LAKES REGION* | | | | | | | | | | |
| 03612500 | Ohio River at lock and dam | 1982 | 496,000 | 156 | 222 | ...... | 171,000 | 283,000 | ... | 6.0 | 13.5 |
| | 53, near Grand Chain, Ill. | 1955–81 | 306,500 | 138 | 362 | ...... | 21,300 | 469,000 | ... | 0 | 14.0 |
| | (25 miles west of Paducah, | (Extreme yr) | | (1962) | (1969) | | (1980) | (1977) | | | |
| | Ky.; streamflow station | | [c]286,000 | | | | | | | | |
| | at Metropolis, Ill.) | | | | | | | | | | |
| | *MIDCONTINENT* | | | | | | | | | | |
| 06934500 | Missouri River at Hermann, | 1982 | 181,000 | 222 | 445 | 146,000 | 98,300 | 237,000 | 6.0 | 3.0 | 12.0 |
| | Mo. (60 miles west of St. | 1975–81 | 50,330 | 253 | 770 | 56,000 | 34,600 | 133,000 | 3.0 | 0 | 14.0 |
| | Louis, Mo.) | (Extreme yr) | | (1980) | (1978) | | (1980) | (1975) | | | |
| | | | [c]40,520 | | | | | | | | |
| | *WEST* | | | | | | | | | | |
| 14128910 | Columbia River at | 1982 | 153,000 | 101 | 115 | 44,600 | 30,600 | 55,500 | 6.5 | 5.0 | 8.0 |
| | Warrendale, Oreg. | 1975–81 | 155,100 | 82 | 119 | 44,000 | 22,800 | 77,300 | 7.0 | 0.5 | 10.5 |
| | (streamflow station | (Extreme yr) | | (1975) | (1978) | | (1978) | (1980) | | | |
| | at The Dalles, Oreg.) | | [c]87,495 | | | | | | | | |

[a]Dissolved-solids concentrations when not analyzed directly, are calculated on basis of measurements of specific conductance.
[b]To convert °C to °F: [(1.8 X°C) + 32] = °F.
[c]Median of monthly values for 30-year reference period, water years 1951–80, for comparison with data for current month.
*Temperature records not available.

# SELECTION AND INVESTIGATION OF SITES FOR THE DISPOSAL OR RADIOACTIVE WASTES IN HYDRAULICALLY INDUCED SUBSURFACE FRACTURES

The abstract and illustrations below are from the report, *Selection and investigation of sites for the disposal of radioactive wastes in hydraulically induced subsurface fractures,* by Ren Jen Sun: U.S. Geological Survey Professional Paper 1215, 87 pages, 1982. This report may be purchased for $5.50 from the Eastern Distribution Branch, Text Products Section, U.S. Geological Survey, 604 South Pickett St., Alexandria, VA 22304 (check or money order payable to U.S. Geological Survey); or from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (payable to Superintendent of Documents).


## ABSTRACT

Injection of intermediate-level radioactive wastes (specific activity of less than $6 \times 10^3 \mu Ci/mL$, consisting mainly of radionuclides, such as strontium and cesium, having half-lives of less than 50 years) mixed with cement into a thick shale formation is a promising and feasible disposal method. (See figure 1.) Hydraulic fracturing provides openings in the shale to accommodate the wastes. Ion exchange and radionuclide-adsorption materials can be added to the grout during mixing to further increase the radionuclide-retaining capacity of the grout. After solidification of the grout, the injected wastes become an integral part of the shale formation, and therefore the wastes will remain at depth and in place as long as the injection zone is not subjected to erosion or dissolution.

Problems concerning safety of the disposal method are (1) the potential for inducing vertical fractures, (2) phase separation during and after the injections, (3) the reliability of methods for determining the orientation of induced fractures, (4) the possibility of triggering earthquakes, and (5) radionuclides being leached and transported by ground water.

In bedded shale, a difference between tensile strength normal to and that paralled to bedding planes favors the formation of fractures along bedding planes that are nearly horizontal. Even in areas where vertical stress is slightly greater than the horizontal stresses, nearly horizontal bedding-plane fractures can be hydraulically induced in shale at depths less than 1,000 meters. Test injections should be made during site evaluation to determine if horizontal bedding-plane fractures can be induced.

The orientation of induced fractures can be indirectly monitored by recording injection pressures during injection time and by measuring the decay of water injections and the uplift of ground surface after the injections (fig. 2); however, it can be directly determined by gamma-ray logs made in observation wells before and after each injection, if the injected fluid or wastes contain enough gamma-ray emitting radionuclides.

If waste grout is properly mixed, phase separation should be less than one percent of the total amount injected. The mobility of waste in the separated liquid is further decreased by the low permeability (less than $10^{-6}$ darcy) and the large ion-exchange and adsorption capacity of shale, which thus reduce the potential for contamination.

Grout injections do not cause extensive increases in pore pressure within shale, and a disposal site should be located in a geologically stable and tectonically relaxed area, that is, an area lacking local active faults. Thus a disposal in shale in such areas can avoid the two necessary and essential conditions for triggering earthquakes by fluid injections, and increase in pore pressure and rock already stressed near its breaking strength.

Waste injections are made in several stages at different levels through an injection well. After the first series of injections at the greatest depth, the well is plugged by cement at that depth. The second series of injections are made a suitable distance above the first. The repeated use of the injection well distributes the cost of constructing injection and monitoring wells over many injections, thereby making hydraulic fracturing and grout injection economically attractive as a method for the disposal of radioactive wastes.

Theoretical considerations about inducing nearly horizontal bedding-plane fractures in shale are discussed, as are field procedures for site selection, safety, and the monitoring and operation of radioactive waste disposal. Case histories are used as examples to demonstrate the application of the theory and techniques of field operations.

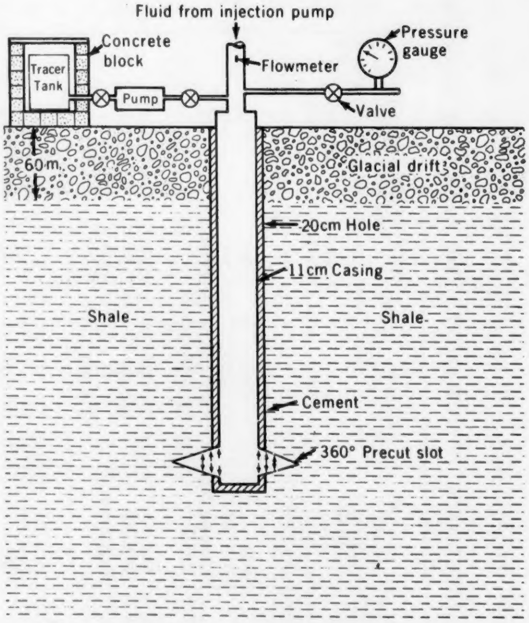




Figure 1.—Schematic diagram of the injection well, West Valley, N.Y.

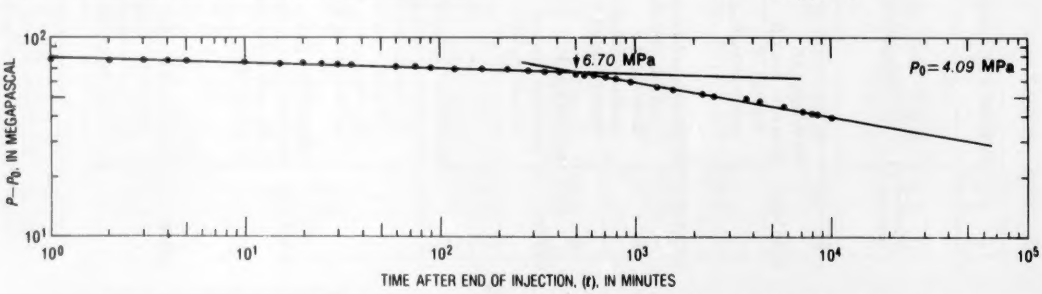



Figure 2.—Pressure decay plotted against time, the water injection at 442 m, Oct. 9. 1969, West Valley, N.Y.

# NATIONAL WATER CONDITIONS

**December 1982**

Based on reports from the Canadian and U.S. Field offices; completed January 11, 1983

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## EXPLANATION OF DATA

*Cover map* shows generalized pattern of streamflow for the month based on 18 index stream-gaging stations in Canada and 164 index stations in the United States. Alaska and Hawaii inset maps show streamflow only at the index gaging stations that are located near the points shown by the arrows.

Streamflow for the current month is compared with flow for the same month in the 30-year reference period, 1951–80. Streamflow is considered to be *below the normal range* if it is within the range of the low flows that have occurred 25 percent of the time (below the lower quartile) during the reference period. Flow is considered to be *above the normal range* if it is within the range of the high flows that have occurred 25 percent of the time (above the upper quartile).

Flow higher than the lower quartile but lower than the upper quartile is described as being *within the normal range*. In the National Water Conditions, the median is obtained by ranking the 30 flows for each month of the reference period in their order of magnitude; the highest flow is number 1, the lowest flow is number 30, and the average of the 15th and 16th highest flows is the median. One-half of the time you would expect the flows for the month to be below the median and one-half of the time to be above the median.

Statements about *ground-water levels* refer to conditions near the end of the month. The water level in each key observation well is compared with average level for the end of the month determined from the entire past record for that well or from a 30-year reference period, 1951–80. *Changes in ground-water levels*, unless described otherwise, are from the end of the previous month to the end of the current month.

Dissolved solids and temperature data for December are given for six stream-sampling sites that are part of the National Stream Quality Accounting Network (NASQAN). Dissolved solids are minerals dissolved in water and usually consist predominantly of silica and ions of calcium, magnesium, sodium, potassium, carbonate, bicarbonate, sulfate, chloride, and nitrate. Dissolved-solids discharge represents the total daily amount of dissolved minerals carried by the stream. Dissolved-solids *concentrations* are generally higher during periods of low streamflow, but the highest dissolved-solids *discharges* occur during periods of high streamflow because the total quantities of water, and therefore total load of dissolved minerals, are so much greater than at time of low flow.

## METRIC EQUIVALENTS OF UNITS USED IN THE NATIONAL WATER CONDITIONS

1 foot = 0.3048 meter

1 acre-foot = 1,233 cubic meters

1 million cubic feet = 28,320 cubic meters

1 cubic foot per second =
0.02832 cubic meters per second =
1.699 cubic meters per minute

1 cubic foot per second · day = 2,447 cubic meters

1 mile = 1.609 kilometers

1 square mile = 259 hectares = 2.59 square kilometers

1 million gallons = 3,785 cubic meters =
3.785 million liters

1 million gallons per day = 694.4 gallons per minute =
2.629 cubic meters per minute =
3,785 cubic meters per day

(Round-number conversions, to nearest four significant figures)



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